

ABSTRACT

A vertical cavity surface emitting laser (VCSEL) includes a substrate; a first mirror stack over the substrate; an active region having a plurality of quantum wells over the first mirror stack; a tunnel junction over the active region, the tunnel junction including a modulation-doped layer; and a second mirror stack over the tunnel junction. The modulation doped layer can be used for either the n-layer or the p-layer, or the both layers of the tunnel junction. Such tunnel junctions are especially useful for a long wavelength VCSEL.